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THE

Journal of the Society of Arts,

AND OF

THE INSTITUTIONS IN UNION.

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Announcements by the Council.

ORDINARY MEETINGS.

Wednesday Evenings at 8 o'clock.

DEC. 7.—"On the Construction, Retardation, Safety, and Police of Railway Trains." By W. BRIDGES ADAMS, Esq.

DEC. 14.—"On the Recent Progress and Present State of Industry in Ireland; and the Dublin International Exhibition of 1865." By Sir ROBERT KANE, F.R.S. On this occasion Lord DUFFERIN will preside.

DEC. 21.—The Articles sent in Competition for the Art-Workmanship Prizes will be Exhibited, and a Report in connection therewith will be read.

CANTOR LECTURES.

There will be three Courses of "Cantor" Lectures on the following subjects during the ensuing Session:—

"On the Reproduction of Natural Forms by Art and Manufacture." By B. WATERHOUSE HAWKINS, Esq., F.G.S., F.L.S.

"On the Application of Geology to the Arts and Manufactures." By Professor D. T. ANSTED, M.A., F.R.S.

"On the Application of Chemistry to the Arts." By Dr. F. CRACE CALVERT, F.R.S.

The following is a syllabus of Mr. Hawkins's course, with the dates of delivery:—

DEC. 12TH.—LECTURE I.—INTRODUCTORY:—On the nature and probable influence of museums of natural history and art collections, and their effect on the public mind and taste. (Illustrated.)

DEC. 19.—LECTURE II.—Demonstrations of the unity of plan in the external forms of animals, the just appreciation of which facilitates the work of the artistic producer, and adds to the enjoyment of the intelligent possessor of works of art.

JAN. 16TH, 1865.—LECTURE III.—On the varieties of artistic treatment of the forms of animal and vegetable life—pictorial representation; conventional ornamental, allegorical, and symbolic combinations of animal forms.

JAN. 23RD.—LECTURE IV.—On the fitness of designs, and their adaptation to the conditions of the materials in which they are to be produced. (Demonstrated by metal-work processes, sand-moulding, casting, and chasing).

JAN. 30TH.—LECTURE V.—On Ceramic Manufactures, with the Influence of the material on the design and its successful production—modern Terra-Cotta, Della Robbia ware, Majolica, and Parian.

These Lectures are open to Members free of charge, and a Member has the privilege of introducing ONE Friend to each Lecture.

ART-WORKMANSHIP PRIZES.

Articles (ninety-six in number) sent in competition for the Art-Workmanship Prizes, have been received from seventy-three competitors, and will be arranged for exhibition in the Society's rooms on and after Wednesday, the 21st instant.

Proceedings of the Society.

THIRD ORDINARY MEETING.

Wednesday, November 30th, 1864; Captain Douglas Galton, R.E., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Barnes, Joseph, 5, St. Thomas'-street, Borough, S.E.
Batson, John, 42, Brewer-street, Golden-square, W.
Dear, Alfred, Pavilion, Belgravia, S.W.
Dear, Arthur, Pavilion, Belgravia, S.W.
Forristall, Michael, The Hermitage, Forrest-hill, S.E.
Grundy, John, The Middle Temple, E.C.
Hall, J., 29, Warwick-square, S.W.
Huth, Edward, Oakfield Lodge, Huddersfield.
Lane, William James, 5, Studley-villas, Studley-road, Clapham, S.
Lord, James, St. John's Lodge, Wandsworth-common, S.W.
Monteith, James, 38, Duke-street, St. James's, S.W.

Moss, William H., 19, Parliament-street, Hull.
Rochussen, Theodore Anthony, 9, Friday-street, E.C.
Saunders, Edwin, 13*a*, George-street, Hanover-square, W.
Schweizer, J. J., 28, Poole street, New North-road, N.
Scott, Rev. C. B., 19, Dean's-yard, Westminster, S.W.
Turner, Henry, St. Joseph's road, Higher Tranmere, Birkenhead.
Twentyman, William Holme, Manor-hill, St. John's-wood, N.W.
Vaudrey, Henry, 10, Norland-square, Notting-hill, W.
Walker, G. H., Rugby.

The following candidates were ballotted for and duly elected members of the Society:—

Altschul, Dr. D. H., 9, Old Bond-street, W.
Bickerstaff, William Martin, 13, Highbury-terrace, N.
Bussell, Charles, 26, Soho-square, W.
Clauson, Charles A. R. (Messrs. Rogers, Bros., and Co.), Naples.
Clutton, Robert, Hartswood, Reigate.
Craven, Joseph, Dole Mill, Thornton, near Bradford, Yorks.
Crowther, Wm., Chemical Works, Gomersal, near Leeds.
Darkin, Charles James, 21, Victoria-terrace, Finchley-road, N.W.
Dyer, George, 90, Regent-street, W.
Eskell, Abraham, 8, Grosvenor-street, W.
Evans, John James, Rose-bank, Rock-park, Birkenhead.
Field, John Lyon, Upper Marsh, Lambeth, S.
Ford, Herbert, 8, Pier-road, Erith, S.E.; and 1, Charlotte-row, Mansion-house, E.C.
Frean, G. H., Mill-street, Dockhead, S.E.
Gilbert, Arthur, 12, Claverton-street, Pimlico, S.W.
Green, German, 7, Helmet-row, Saint Luke's, E.C.
Hannah, Robert, 2, Alfred-place West, Brompton, S.W.
Hart, John Matthias, 76, Cheapside, E.C.
Haysman, Jas., F.R.G.S., Burdett House, Burdett-rd., E.
Hollow, Richard Welch, York.
Hudswell, W. S., New Railway Foundry, Leeds.
Huggon, William, 30, Park-row, Leeds.
Lainson, Henry, Heath-house, Reigate.
Leycester, George Percival, 6, Oak Hill, Hampstead-road, N.W.
Locket, George, Acton-house, Rosslyn-park, Hampstead, N.W.
Mather, William, Chester-road, Manchester.
Morres, Edward, 43, Parliament-street, S.W.
Nosotti, Charles, 398, Oxford-street, W.
Oertling, Ludwig (Ladd and Oertling), 27, Moorgate-st., E.C.
Oram, John White, 7, Bank-buildings, E.C.
Payne, James Bertrand, 44, Dover-street, W.
Page, Nathaniel, Stag Brewery, Pimlico, S.W.
Pankhurst, R. M., LL.D., South King-street, Manchester.
Robinson, James Edward, Pontefract.
Smith, Joseph, 3, Percy-villas, Wells-st., Hackney, N.E.
Snooke, William, 6, Duke-street, London Bridge, S.E.
Talbot, Robert, Strand-on-Green, Chiswick, W.
Taylor, John, 45, Connaught-terrace, W.
Tucker, Silas, 54, Canonbury-park south, N., and 234, High Holborn, W.C.
Turnbull, Thomas, jun., Whitewell Dockyard, Whitby
Venables, William Vernon, 6, Queen-street-place, E.C., and 20, Canonbury-villas, N.
Wagstaff, John Henry, 9, Sheldon-street, Bishop's-road, Paddington, W.
Walker, W., jun., J.P., Red Hall, Shadwell, near Leeds
Watkins, Major-General, B 3, Albany, W.
Watson, Edward Façon, 201, Piccadilly, W.
Watson, Thomas, 19, Highbury-crescent, N.
Wentworth, J. W. T. Vernon, Wentworth Castle, Barnsley
Whiteside, R. B., 49, Lime-street, E.C.
Whitford, Edward Edmondson, 55, Lansdowne-road, Kensington-park, W.
Willing, James, 366, Gray's-inn-road, W.C., and South Lodge, Ham, S.W.
Wilson, Captain J. H, 35, Pembridge-villas, Bayswater, W.
Wilson, George, Nunthorpe Hall, York.
Wilson, Thomas, 20, Gloucester-square, Hyde-park, W.
Woodthorpe, Edmund, 28a, Basinghall-street, E.C.
Wrentmore, Francis, 250, Regent-street, W.
Yallop, Thomas, 39, Norfolk-square, Hyde-park, W.

And as Honorary Corresponding Members.

Bonghi, Cavaliere Diego, 38, Vico S. Guiseppe de Midi, Naples.
Knight, J. G., Melbourne, Victoria.

The Paper read was—

ON THE MECHANICAL CONDITIONS OF RAILWAY WORKING TO PREVENT DESTRUCTIVE WEAR AND RISK.

By W. Bridges Adams.

This is a subject not of mere local or of class interest. In days gone by, when a man was by the mass of Cockneys esteemed a traveller if he had been to Gravesend and back, it would have interested but a very few to discourse on the means of transit, but in the present day, all men, women, and children have become locomotists, getting back to a state of nature, like the birds and wild animals, and no longer confined to the spot on which they are born and bred. And a very good thing it is for themselves and general humanity, for they thereby become educated, not in the sense of book learning, but in the sense of knowledge of men and things, expanding their thinking faculties with the more healthy growth of their bodies. We increase thereby the number of men and women, instead of mere human animals, and we increase also national power, which is not to be measured by animal units, but by the mass of intelligence, health, and physical strength —in short vitality. It is better to soar like birds than to burrow like rats; and though we cannot soar above the earth, with guiding power like birds, we contrive to skim along the surface though not quite so fast, and do not yet see our ultimate limit to speed accompanied by safety. We are fast becoming a nation of mechanicians, and each man's strength is as the strength of ten, as fast as he acquires a sound body for a sound mind to dwell in. The subject is possibly a dry one in its details, but out of these dry facts must come the growth of progress, and this must be the writer's apology for dwelling on them, though in as succinct a mode as language will permit. In criticising any subject it is but natural that the critic should devise plans for amending that which he deems wrong, and in so doing the writer would deprecate any appearance of egotism in dealing with his own plans.

In vehicular transport the contact between the vehicle and the road it moves on may be of three kinds, sliding or sledging, rolling, and a compound movement, partly sledging and partly rolling. The sliding movement may be converted into rolling by the application of water, oil, or unguents, the particles of which form rolling bodies between the vehicle and the road, as with the ship on water, or with the wine sledges used in Madeira, where the driver sluices the road beneath the sledge runners, or with the winter sledges of cold climates, where frozen surfaces supply rolling particles. If actual contact between the moving vehicle and the road take place without the intervention of rollers or lubricants, destruction must ensue by abrasion.

Where no means exist of supplying lubricants to the road surface, the next process to ease the sledge is to place rollers under it. If the rollers be true cylinders, and are not fixed to the sledge, and the movement be in a straight line, there will be absolute movement without friction. If the rollers be fixed to the sledge, by axles passing through them and bearing the load, the friction will be transferred to the surface of the axle from the surface of the road, and will be greatly reduced if the oil or unguent forms an efficient lubricant. If the roller bears on the road through its length, and be a true cylinder, it will move forward in a straight line. If it be of a conical form it will move in a curved line corresponding to the cone. But if two coned rollers be fixed to the sledge with their axles parallel, the movement will be partly sliding and partly rolling, with great friction in a straight line. If the two coned rollers be not parallel, but are arranged with their axles in converging lines corresponding to the cones, the machine will move in a circle, the centre of which will be the point where the converging lines intersect each other.

The ancient Greek and Roman cars were mounted on rollers, *i.e.*, a pair of wheels connected by a fixed axle running between thole-pins, such as up to the present day we see in the wine-cart of Portugal and parts of Spain, which are unfitted to turn corners, and make so fearful a squeaking when running out of a straight line as to give rise to the jest that they are so ordered to give warning to the custom-house officer in case of smuggling. Double-roller cars also existed, with fixed parallel axles, and this faulty mechanism was probably one cause why the old Roman roads were made in straight lines, as it was easier for such cars to run up hill than to follow curves. Even supposing the case of four-wheeled cars with two wheels running independently on their axles, these cars could still only run in straight lines as long as their axles were rigidly parallel; and in England it was only during the reign of Queen Elizabeth that what were called "turning carriages" first existed, *i.e.*, with a mechanism that permitted the axles to depart from their fixed parallelism to pass round curves.

When railways, as distinguished from tramways, were first commenced, the faulty mechanism of the early classic cars was resorted to as a cheap structure—cheap in first cost. Wheels proper were ignored—*i.e.*, wheels running independently on their axles—and rollers were used, *i.e.*, two wheels fixed to a shaft or axle which revolved with them in thole-pins, or what are now called horn-plates. And, whether two axles or three or more were used, they were always rigidly parallel. And this is the common practice in England to this day.

What are called tramways are formed of flat plates of iron, with rising edges to keep the wheels in track. Ordinary wheels, revolving independently on their axles, were used on them. Their mechanical disadvantage was that dust and dirt accumulated on the horizontal plates, and the wheels rubbed hard against the rising edges as against kerbstones, and caused much friction. Opinions are divided as to the origin of the term tramway, whether derived from an originator named Outram, or from the word "trammel," to curb or guide. The term "plate-layer," on railways, is evidently derived from the original tram-plates. On railways proper, what is called the edge rail is used, in which the increased depth gives greatly increased strength to support the load, and at the same time dust and dirt have little chance of remaining on the rails. But to keep the wheels on, the rising ridge or kerb of the tramway is transferred to the wheel, in the form of a flange. It is clear that vehicles with fixed wheels and parallel axles are only adapted to move in straight lines. If the axles were converging, the vehicles would only move in curved lines. But there is another common condition, a result of faulty workmanship—parallel axles not at right angles to the line of traction; in this case the machine becomes a sledge under all conditions, with the wheel flanges constantly grinding against the rails.

With a view to compensate, on curved lines of rails, for the different lengths of pathway on the two rails, it has been a practice to make the wheel peripheries conical instead of clindrical; *i.e.*, each pair of wheels fixed on the axle being practically a garden roller, with the central portion removed, are made at each end a frustrum of a cone, with the smallest diameters outside. Were the roller solid, *i.e.* were the coned lines prolonged till they met in the centre, the roller, if balanced, might run in a straight line, or it might run in a curved line to right or left, if bearing on either cone, the curve being regulated by the angle of the cone. This would be the case with a single roller. But it is a fallacy to suppose that two or more rollers fixed in a frame, with their axles permanently parallel, would follow the same conditions, even though sufficient end-play were allowed between the flanges and the rails to make the differing diameters across the breadth of the tires available to compensate for the differing lengths of the rails. The movement in a straight line might be free rolling at low speed, provided the cones had sufficient lateral movement or end-play, but on curves it would only be sliding or sledging. But if the frame were so arranged that the axles were permanently out of parallel by reason of careless workmanship, the machine would be a constant sledge both on straight and curved lines. So also if the axles were perfectly parallel, with the wheels in the same plane, but were not placed at a right angle with the line of traction, the result would be constant sliding friction.

In any of these four conditions—whether a truly constructed frame, with parallel axles, or badly constructed with axles out of parallel, or badly constructed with parallel axles and wheels out of plane, or not at a right angle with the traction rod, though the first may roll at intervals under a favourable condition, the three latter must always slide, and the resistance to traction will be in proportion to the roughness of the rails and the load on them. With a light vehicle, little loaded, smooth wheels and polished tires and rails, and especially if they were lubricated on the surface, the resistance might be very small. Nay, a sledge might even be better than a wheeled vehicle, if only the condition of a lubricant could be retained. But a lubricant on the rail is inadmissible, first, because it would cause dirt to adhere to the rail, and secondly, it would defeat the condition of adhesion essential to the traction by the locomotive engine. The engine needs the greatest possible amount of adhesion, corresponding to the steam power. The vehicles should be so constructed as to minimize the amount of resistance. But as at present constructed, the vehicles on a railway are in principle a reproduction of the old Roman cars on two rollers, with such variation as a better or worse condition of workmanship or lubricant may induce, and the change from a common road to a railroad.

Axle friction, under the best conditions, is commonly estimated at about four pounds per ton of load, but this is usually doubled by a condition that under the best treatment ought scarcely to exist, viz., "rolling friction" *i.e.* the friction of the tires on the rail, and thus at a moderate speed on the level, eight pounds per ton is estimated as train resistance. But this, it is well known, is very far short of the real resistance in practice, which by quick curves and bad structure may be quadrupled and quintupled, varying with the speed of movement.

A river running with a slow movement may pass along a winding channel without disturbing its banks; but the same river, with its speed increased by sudden influx of water, seeks to make a straight course, and cuts away its banks, or *rives* them, in a mode corresponding to its etymology. Even so, a railway train at high speed becomes a *river* of the rails, at an increased cost of coke converted into steam; and, like the river water, it produces debris, not in the form of gravel, but of black iron powder, as anyone may verify by rubbing his finger along the rails after the passage of a train. This is frictional destruction, increased or diminished, in proportion to the load on each wheel.

But there is yet another element of destruction—percussion or blows, which take place between wheel and rail, friction and percussion being the only sources of mechanical destruction on railways—the others being chemical. It is quite clear that were a train to stand still on a railway, and never move, it might rust and rot, but it would not wear out, and though the proverb is a sound one "better rub than rust," it is still better to do neither. The movement of the train begins the great destruction, and it is want of compensation for irregularities—a condition never disregarded by nature—that causes the destruction. The wheels, when running on unequal paths, induce great torsion of the axles by friction on the rails. At bad joints or uneven surfaces the wheels jump from the rails, and they then recover their normal position, by the axle as it were unwinding itself, like a discharged spring, and striking a violent blow on the rail. Sometimes the wheels, with the axles in a state of torsion, drag along for a considerable distance, heavily loaded, and this is a fruitful source of axle breakage, as well as of rail destruction. Again the flanges strike against the rails from side to side, and a constant succession of blows and vibrations is induced throughout the whole of the train. And with long vehicles, on sharp curves, there is a constant tendency to grind the flanges and burst out the rails. The rapid wear of wheel tires and rails yields ample evidence of this, and the probability is that at high speed the movement is as much sliding as rolling—side as well as forward sliding. But for the partially polished surfaces of both wheels and tires facilitating slip, at the loss of adhesion on the driving wheels, it is probable that the destruction would be much more rapid.

Are there proofs needed of all this? Time was that rails of 60 lbs. per yard, and Staffordshire tires too tough in texture to break, were capable of considerable duration. They have gone by, and rails, after various experiments in making them harder in iron, have grown to 84 and 90 lbs. per yard, and now with Bessemer steel for metal; and tires, after running through the phases of Park-gate, Low Moor, and Leeds, and various plans for steeling their surfaces, have now culminated in Krupp's solid steel.

It is many years since the writer became aware of the importance of elastic action, even on wood wheels used on highways and paved streets, to induce durability, and facilitate traction, when high speeds were needed. In the structure of the ordinary wood wheel the strength resides in the tire, which keeps the weak frame together. Originally, wheels were made vertical, *i.e.*, with the spokes all in a plane, and the width of base was determined by the ruts or hollows which pervaded all roads, giving a kind of fixed gauge, much as rails do now. The bodies were placed between the upper part of the wheels; and when it was needed to widen the bodies, the wheels were made in the form of a cone, or what is called "dished," the axle arms being pitched downwards to keep the lower spokes vertical, with an idea of strength, while the upper spokes inclined outwards with a considerable angle. The fellies and tire were made conical, to preserve a flat tread on the ground. It is evident that as these wheels revolved, they were constantly grinding the road, the outer side of broad wheels being considerably less in diameter than the inner, while the vertical spokes were continually driving into the nave and loosening the framing.

After trying some experiments with wheels in which hoops of elastic steel were used to connect the periphery with the nave, instead of spokes, the writer had some made with the section of the wood spokes reversed. The ordinary mode is to make the spokes deepest from back to front, but in the improved samples they were made broad in the plane of the wheel, and thin from front to back. As this was a bad form to fasten in the ordinary nave, it was dispensed with, and a pair of disc plates was substituted, between which the spokes were mitred together and bolted. One felly was used to each spoke, instead of the ordinary practice of one felly to two spokes, and when cylindrical tires—not conical—were shrunk on, the spokes curved from back to front, and the wheel, instead of being a rigid cone, or dish, became an elastic dome, each pair of opposite spokes radiating from the centre, representing the form of an archer's bow. The fastening of the tires was through the joints of the fellies. When applied to a straight axle, with the arms not pitched downwards, the load was carried, not on a rigid vertical, but on a bent inclined spoke, and the result was that the load was not only carried more easily, but the wheels were, for their scantling, the most durable ever constructed.

In the early railway wheels the principle obtained of neglecting the structure of the frame, and making it depend for strength on the shrinking of the tire, just as wood wheels were made. One result of this was the flattening of the tire between the spokes, and a tire of unequal thickness, when turned in the lathe to make the external periphery a true circle, and a consequent rapid destruction in wear. This applied to the wheels with the wrought-iron spokes. The truest formed wheels were those of cast-iron with a wrought tire. They might break if of careless moulding, but they would not otherwise alter their form, and the tires could be all of equal thickness. But upon rigid cast-iron wheels the tires became exposed to very rapid destruction as the loads increased.

The writer had early turned his attention to the importance of wood wheels for railways, and as far back as the year 1838 caused some to be constructed with two rows of fellies, break-joint between the tire, and a cast centre. They worked well, and the writer has been informed that they still exist. The difference between these wheels and the modern wood wheels is that they had the elastic side grain on the tread, whereas the modern wheels have end grain. The reason for substituting the latter less perfect method probably was the difficulty of ensuring dry timber on a large scale, and wood shrinks scarcely at all endwise, so that the shrinkage involves less evil.

Wood wheels on railways are, as now made, solid discs, and therefore the frame preserves its circular form without being excessively rigid. Iron wheels have also been made in the disc form, both in cast and wrought iron; but, then, extreme rigidity rendered the destruction of the tires a very rapid process;—the tire was between two anvils—the frame of the wheel, and the rail supported on chairs of cast iron.

To prevent this destruction the writer early devised a wheel in which the spokes were all springs, but that did not answer, because the bending of the spokes prevented the wheel from running true. The next plan was to apply a hoop of elastic steel between the tire and the periphery of the wheel, with a hollow below the steel. The wheel was retained in the tire by a rising rib in front, solid with the tire, and by a lower rib behind, sprung into a groove of the tire. Models are on the table and a section on the wall.

The plan was satisfactory in theory, but how to put it in practice was another matter. A railway was needed, and railways are not to be found in a private field or park; they are the highroads of the public, and in charge of officers whose first care is to take no risk by an unknown plan; for if an accident happens through a known plan in common use, however faulty in its mechanical philosophy, a jury will acquit the manager of all blame. But if the accident happens with a novel plan, however theoretically right it may be, the jury will probably condemn it as new-fangled, and saddle the manager or engineer with the blame; and thus there is a natural indisposition in engineers to step beyond their tether into the unknown, and they can hardly be blamed for their caution.

So the writer went forth on his propaganda to expound an unknown quantity, but few would even listen to him, and none would believe; but strong in faith he persevered, and at length found an engineer with a logical mind, in the locomotive superintendent of the North London Railway, Mr. William Adams. The writer demonstrated his principle, and Mr. Adams was unable to disprove it logically, whereon the writer remarked, "If you cannot demonstrate it to be wrong, and I demonstrate it to be right, and that the result if successful must be very advantageous, you are bound to try it." He agreed to this, and said "I will try it, though doubting greatly. What wheels will you apply it to?" "Those most destructive to tires."

So a set of wrought iron disc wheels were selected, and Staffordshire tires were applied to them on hoop springs, and they were placed under a heavy carriage. At the same time a set of ordinary spoke wheels, with a set of Low Moor tires fixed in the rigid mode, were applied to a similar carriage. The Low Moor tires required turning up to restore their surface after running less than 50,000 miles. The Staffordshire tires on springs ran 106,000 miles without turning up, and with no alteration of form, and were then taken off to exhibit, and may still be seen in the same condition.

There is no mystery in this. The Low Moor tires were exposed to severe wear. First, because on curved lines they were necessarily forced to slide on the rails, both forward and laterally. Secondly, because they were rigidly fixed, and possessed no elastic yielding to elude blows. Thirdly, because on curved lines there was a constant torsion of the axles causing incessant jumping. Fourthly, because the tires had no power of lateral movement to suit the varying inequalities of the rails. In short, there was no compensation for irregular movement, and the result was a constant grinding of the flanges and treads.

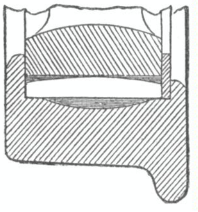
With the spring tires, on the contrary, there is universal compensation. First, there is no tendency to blows, because the elastic cushion preserves constant contact between tire and rail. Secondly, there is no torsion of the axle or slipping of the tires on the rail because the wheel can, on curved lines, slip in the tire on the smooth surface of the spring without damage, thus equalising the pathway. Thirdly, the tire can rock laterally on the wheel to adjust itself to the bearing on the rail surface, which any one may observe to be constantly varying, sometimes the middle of the rail being most prominent, sometime the inside edge, and sometimes the outside. No other class of wheel can supply these various compensations.

Important as these wheels are for vehicles which are simply drawn, in order to remove resistance, they are still more important for engines with the load greatly increased, and especially for driving wheels—more especially for engines with four coupled drivers. It is obvious that if two wheels of equal diameters be fixed on the same crank shaft they must grind and drag on curved lines, and the torsion thence ensuing is the main cause of the breakage of crank axles, which it is difficult to make strong enough for their work, the axle being in reality a a very long axle, as would be readily apparent were it stretched to a straight line—between eight and nine feet long on the narrow guage. When four wheels are coupled, the diameters very rapidly alter by irregular movement, and the adhesion may actually become disadvantageous, retarding the engine by friction, like a brake. It is clear therefore that the power of slipping the wheel within the tire to compensate for curves and irregularities becomes a question of the greatest importance, both as to facilitating haulage and preventing the wear of tires.

It has been at times assumed that the slip of the tire on a wheel must defeat the purpose of haulage. But when it is remembered that the bearing of the wheel is over half the diameter by downward pressure, and that with a heavily-loaded wheel a slight flattening of the tire takes place, it is obvious enough that slip will only take place by excessive friction on the rail; this is the true theory, but, for the satisfaction of those who only believe in practical results, it may be stated that the experiment has been tried repeatedly, and it has been found that when the tires were so loose on the springs as to be turned round by hand with the wheel lifted, the haulage was in no way affected. On a London line, of sharp curves, where the leading tires of ordinary engines with parallel axles had their flanges constantly ground off in two months' wear, a bogy-engine was set to work with a turning centre to radiate the leading axle to the curves. At the same time a similar sized engine, but with parallel axles, was applied with spring tires to the leading wheels. The result was that in both cases the leading flanges were saved from damage, and ran three times the ordinary distance. The yield of the springs had an effect similar to that of the play of the axle to right and left in the bogy, when truly centred, for if not truly centred the flanges wore unequally.

These spring tires were adopted on the engines of the St. Helen's line, by Mr. James Cross, the engineer. That line is an incessant continuation of sharp curves and gradients, some of the latter 1 in 35, and some of the former two chains radius. The spring tires were first applied to a six-wheeled engine, all coupled drivers of 4 ft. diameter. They were all of Staffordshire iron. At the same time another engine of less weight, also on six wheels, but of 4ft. 6in. in diameter, and only four coupled, was fitted with tires of Krupp's steel. After running 41,000 miles, Krupp's tires were so deeply worn as to need turning up, while the Staffordshire iron tires ran 65,000 miles, and then only required the flanges to be reduced which had been deeper at the outset, the tread of the tire remaining in good shape. Taking into consideration the difference of diameter, the distance run by the Staffordshire iron was as 72,000 against Krupp's steel 41,000. In practice, Krupp's tires were found to slip on the rails even in dry weather, but the Staffordshire iron was scarcely ever known to slip, though working steeper gradients and sharper curves.

Another set of experiments was tried with two fellow engines, one of them fitted with spring tires, the other with rigid tires, up a gradient of one in 80, during a whole day, by the same driver. The result was, that the rigid tires constantly drew up thirteen loaded coal wagons, and the spring tires fifteen.



The result of this elastic principle having been so unmistakably advantageous in wheels, the writer began to consider whether the same principle might not be practically applicable to rails also. It is clear that the destruction of rails arises from blows between the wheel tires and the rails, increased in destructive effect in proportion to the load, and therefore it is, that it is now proposed by some railway companies to substitute steel for iron in rails as well as tires.

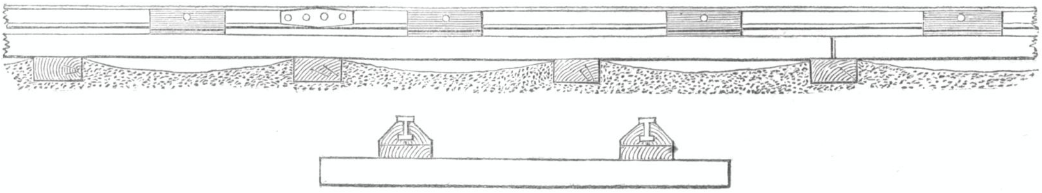
On the North London Railway the rails are 82 lbs. per yard, and their average duration on the main line does not exceed four years, if so much, the traffic on each pair of rails being upwards of 120 trains per diem of goods, coal, and passengers. The great wear is not owing to wear of attrition, but to crushing, disintegration of the laminæ. The rails are double-headed, and worn out on both tables before they are taken out. The sleepers are three feet apart, and the rails are fixed in cast iron chairs with wooden keys, the joints being fished with long fishes and four bolts.

Iron rails are in their manufacture practically "scrap iron." They are formed of bars of various sections piled together and heated, and then rolled out. In the act of heating, the oxygen of the atmosphere gets access to their inner surfaces, and scale is formed. This scale does not roll out, but rolls in, keeping up a constant separation of fibres like the grain of wood. With a certain intensity of blow on the line, the chairs and sleepers serving as anvils, the fibres are crushed apart, and the utility of the rails is destroyed.

Steel rails are not formed of separate masses welded together, but each of a single ingot rolled out without flaw or imperfect junction. They are homogeneous, which the iron is not, and therefore do not disintegrate with the same amount of blow which disintegrates the iron. But to be safe, the steel rail requires to be not only homogeneous in metal, but in the temper of the metal also. If a steel rail be taken hot out of the rolls and thrown on a cold iron or stone floor, it may become partially chilled—hard and soft—and in this condition it is apt to break, for which reason it is always recommended to keep the steel rails as soft as possible, to prevent risk, in fact to reduce them to the condition of iron. But the better plan would be to use spring steel, and harden and temper it.

There is a notion prevailing that permanent way on cross sleepers is elastic by virtue of its discontinuous bearing. But it is obvious that if there be any yield of the rails between the supports, there is none at the chairs themselves. If the rail be loose in the chair, which it commonly is, and if the sleepers be loose in the concreted ballast, which they are commonly, the looseness only serves to give momentum to the blows of the wheels, so that the rail drives into the chair, the chair drives into the sleeper, and the sleeper drives into the ballast, while the fish joint bends at the weakest point.

On a portion of the main line of the North London, the rails and chairs being taken up, longitudinal timbers, four inches deep by eleven inches wide, were spiked down to the sleepers. On these longitudinals, midway between the sleepers, were placed cast-iron brackets in which the rails were fixed, suspended by the upper table, and not resting on the lower table, as in chairs, the bottoms of the rails being 1¼-inch above the longitudinal timber, so as not to touch it. The joints were fastened as usual. The cross sleepers were packed hard and tight on solid ballast. The longitudinal timbers were not packed, the result being that the rails were continuously supported on an elastic base. With the traffic of the trains the mechanical action was, that no wheel pressed directly on a single sleeper with a hard blow, but that the weight on each wheel was distributed over two or more sleepers, and that through an elastic medium. Practically, after nearly three years' wear, none of these rails have been found to disintegrate, but are as perfect as when first laid down, except where connected rigidly to the ordinary line, and there the ends of the rails are split; and the elastic action is not merely vertical, but horizontal also, by a slight twist of the longitudinal timbers preventing side blows from the flanges of the wheels.

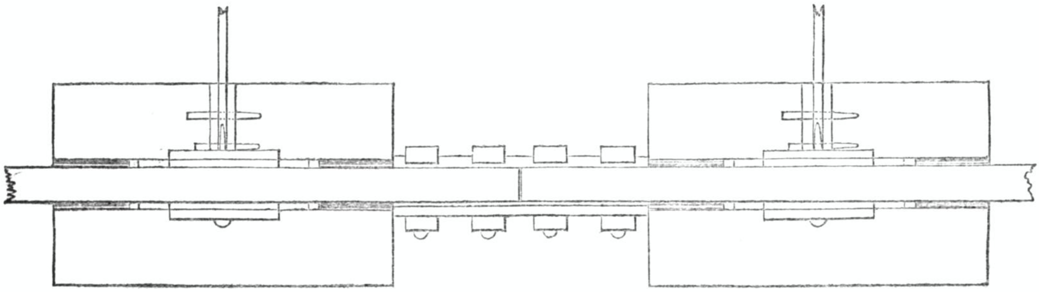


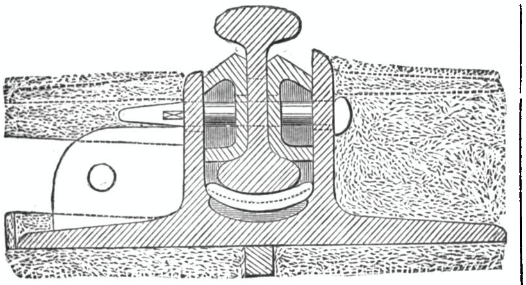
It was also found that the sleepers remained quite undisturbed in the ballast, owing to the distribution of the weight, and that they really became *sleepers*, instead of dancing up and down. Moreover, the provision for elastic action dispensed with the practice occasionally resorted to of digging up the ballast below the sleepers to soften it, and prevent the extreme rigidity. It is getting to be a known fact that constant traffic and the use of heavier engines and vehicles is gradually solidifying the whole of the railway lines, so that the destruction of the plant, both fixed and rolling, is on the increase. A superintendent of a long line running on hard ground informed the writer that he contemplated re-spacing the whole of his sleepers in order to use the softer intervals. An illustration of this great evil may be found in the fact that in the winter time, when all the ground becomes hard with frost, the destruction of wheel tires and rails by breakage, is greatly on the increase.

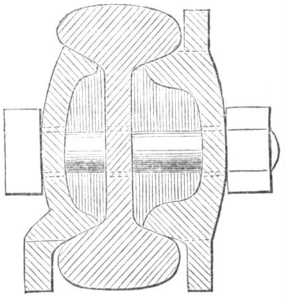
After the successful result of the first experiment on elastic lines, the superintendent of permanent way, Mr. Matthews, laid down a second portion, in which the cross-sleepers are six feet apart, or double the ordinary distance, the supports of the rails on the longtitudinals being three feet apart. The same result was obtained in preserving the sleepers steady in the ballast, though the elastic yielding was greatly increased, being quite perceptible under the rolling trains.

Ballast in England and elsewhere has become a kind of stereotyped custom on railways, though there are districts, as Egypt,—the Southern States of America—where a driver "guesses he never run on ballast but only on mud roads"—the Pampas of Buenos Ayres, the Llanos of Venezuela, and elsewhere, where no ballast can be had, and so it is dispensed with. But the theory of ballast has hardly been considered. It was originally used on non-porous soils, as a kind of easy drainage for surface water, and in some places tolerably cheap. And it does not yield like clay. But it very soon ceases to be porous under the sleeper, and becomes a kind of conglomerate, or concrete, each sleeper pit holding water like a pond. But inasmuch as it has been practically demonstrated that with a provision for elasticity the sleepers may advantageously be rigid fixtures, there seems to be no reason why the whole surface of a railway should be covered with eighteen inches of gravel or broken stone, varying in price from 1s. to 2s. 6d. per cubic yard. The object should be rather to cover it with non-porous material, so as to keep out the surface water, the same principle on which we pave the footways of our streets; and there is no doubt that it would be cheaper in many cases to use stone flags or cast-iron for sleepers, rigidly fixed and overlaid with elastic longitudinals, so as to dispense with ballast, even in first cost, saying nothing of the saving in maintenance. As regards such lines as are constructed on brick arches, the elastic system would prevent the vibration which so commonly disintegrates them, and, by ramming down the ballast, forces out the parapets; and it would be better to cover the surface with non-porous material, such as paving stones, and get rid of mud and dust altogether. The action of this novel system depends upon the elasticity of the longitudinal timber, but inasmuch as there are circumstances in which timber is inadmissible, such as very hot climates, or climates of great heat and moisture combined, or alternating, the writer was led to consider whether it might not be practicable to obtain the elasticity by the agency of metal. This can be done in two methods, substituting a broad **T** iron for the longitudinal timber, or by applying springs of tempered steel beneath the seats of the rails, which in that case cannot be suspended by the upper table, but must rest below the vertical web, being supported between the bracket sides with provision for the small amount of movement required. Two models of cast sleepers are on the table, with elastic steel bases. The cost of them will not exceed ordinary iron way, as great weight of metal is saved.

It is desirable that the rails should be of such depth as not to deflect beneath the wheels, and also that they should not deflect laterally, for which reason the tables should be of ample width. It is also important that the rails should be so joined together as to form non-deflecting bars at the joints, though with provision for expansion and contraction. In examining the ordinary fishes it will







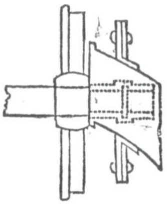
be perceived that the original principles of the writer's invention have not been carried into effect. These fishes, as ordinarily used, are parallel bars, about eighteen inches in length, and with four bolts to attach them to the rails. As the total depth of the fish is only between two-and-a-half to three inches, it is obvious that a pair of three-inch bars cannot possibly be equivalent in strength to a rail five inches in depth, and provided with two broad tables. In order to compensate for this defect in some measure, the fishes are made as thick as possible, approaching an inch, making them very rigid. They are wedge-formed between the rail-tables, but at an obtuse angle, not an angle of repose, and they depend wholly on the bolts to keep them in position under the action of the trains, and the slightest movement of the rail loosens them. For this reason the bolts are made as large as possible. The large hole weakens the fishes, and it is necessary to drill the holes, as punching distorts a narrow thick bar. Moreover, as the fish is as thick at the ends as at the centre, the result is a blow from the wheel at the fish end, where it is too strong, and a second blow at the joint where it is too weak, and a gradual dent of the fish-end into the rail, and another dent of the rail-end into the fish; and when these dents begin to form, the process of destruction is certain; rust is formed, rubbed off, and begins again, and the noise and jolt is rendered very perceptible to the passengers before the cause is detected by the eye, except when a train is passing, when the deflection is very perceptible.

To remedy this evil, the writer has devised a true form of fish. It is tapered from the ends towards the middle, where it is the full depth of the rail on the outside fish, and on the inner the full depth of the rail, less the upper table to make room for the wheel flanges. Angular ribs are rolled on the inside of the fishes, to fit accurately against the rail tables, and the fishes are arched laterally. The metal being thin, except at the ribs, they are easily punched without distortion, and when the bolts are screwed tight, the arches of the fishes flatten and press the ribs against the rail tables firmly. The bolts thus acting on elastic surfaces, the nuts remain tight, and the joint is elastically firm. The models of the elastic way, both in timber and iron, with steel springs, as well as the improved fish joint, are on the table.

The writer has dwelt upon this subject the more earnestly because on any new plan connected with a railway, a protracted experiment is needed for verification, and this protracted experiment of elastic railway has been made, and can be examined by all who feel an interest in so important a subject.

Having obtained successful results in the elastic action both of wheels and rails, the next question was to obtain a true mechanical action in the movement of wheels and axles. As far back as the year 1837 the writer had sought to impress upon railway authorities the importance of radial movement in the axles, enabling them to run at a right angle with the rails, whether on straight lines or curves, and proposed various modes of accomplishing it, but he could get no attention. The railways were made in what were called straight lines, though practically crooked lines, and it was taken for granted that the coning of the wheel tires accomplished all that was wished. But in America crooked lines obtained with very sharp curves, in order to go around street corners instead of outside the towns, and a bell was suspended at the entrance, to be struck by the engine, and a notice painted on a maple slab, "Look out for the locomotive, when the bell rings." To facilitate the movement of the engine round the curves, the front end was provided with a swivelling truck, called a bogy, analogous to the ordinary under-carriage of a road vehicle, moving on a centre pin, but with four wheels instead of two, the wheels being guided by their flanges against the rails, instead of by a pole. This was so convenient, that it came into general use in America, and it was first introduced into England on the Birmingham and Gloucester line, the engines being made in America. But it was defective in principle. In ordinary under-carriages on the road, the length of the pole steadies the wheels. In the four-wheel bogy, the distance between the front and back wheels was less than the width between the rails, and, consequently, swivelling on the centre pin, the bogy was apt to run unsteadily, and drag the wheel flanges against the rails, the contact with the outer rail on curves setting the axles askew to the rails. This evil was continued on the South Devon line, where, the sharp curves necessitating the use of the bogy, it was applied on a seven feet gauge with the wheel centres five feet apart. In addition to this defect, apparently resorted to to compensate in some measure for the fixed parallelism of the axles, it did not in any way help the skew position of the driving wheels, as the central pivot did not permit lateral movement of the bogy. To remedy this, Mr. Bissell, in America, devised a plan of removing the centre pivot from midway between the four wheels to a point between the driver and the bogy; thus the movement of the wheels became radial, or in the circumference of a circle instead of the centre. This was a plan on which the writer had built road carriages long previously, under the name of Equirotal carriages, and had proposed to apply the principle to engines. Mr. Bissell subsequently applied the same principle to engines with two-wheeled bogies, and time and circumstances having forced on the attention of English engineers the necessity for radial movement, other attempts were made to correct the defects of the bogy, and one was by providing a lateral slide as well as pivot movement to the centre. But on this plan the guidance was lost, and it was not found to answer.

Seeing that the time was approaching for more perfect machinery and for radiating axles, the writer again set to work to simplify the structure. Abandoning the truck form, or bogy, altogether, the axle-boxes were adapted to slide in curved lines laterally through the horn plates of a rigid engine frame beneath the spring bearings. The advantages gained by this were, first, true radiation of the axle to every curve, from the straight line down to one chain and a half radius; secondly, perfect guidance and prevention of irregular movement in the wheels; thirdly, facility in axle bearings and lubrications; fourthly, the use of larger wheels than could be obtained by the bogy system.



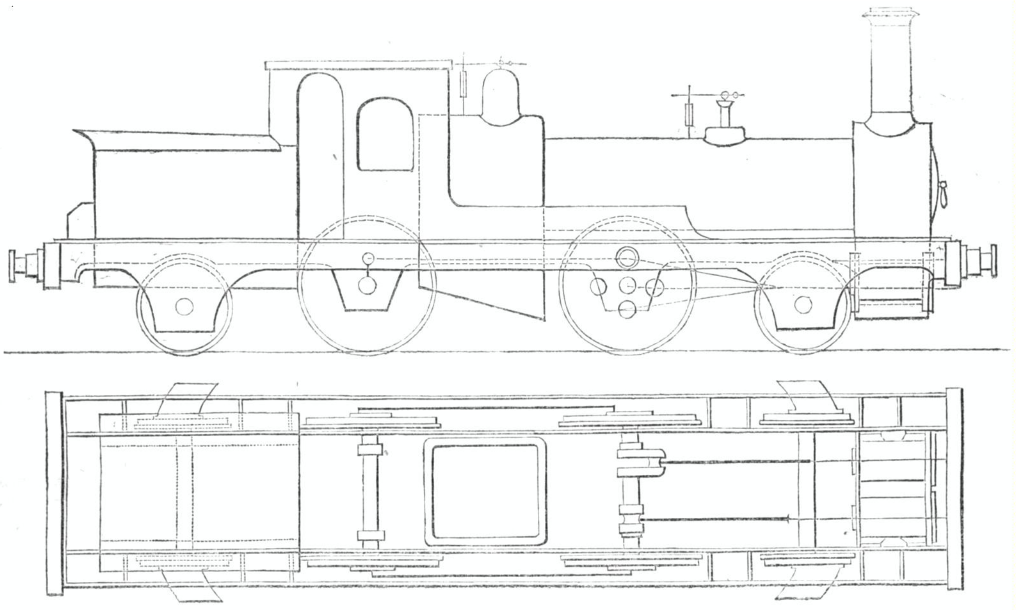
The writer proposed to build the engine with coupled driving wheels in the centre, and with radial wheels at the ends, eight wheels in all, and so, having ample support, to dispense with a separate tender. This was so novel a plan, departing from the customary bogy system, that it was not listened to, and bogies were continued.

The writer sent a drawing to Mr. Cross, the engineer of the St. Helen's, and about nine months after received a letter from that gentleman stating that having found it necessary to use larger engines for his increasing traffic, he had studied the whole question carefully as to the best principle of radiation for his sharp curves; and having come to the conclusion that the plan of the writer was the simplest, safest, and most effective, as well as the least costly, he had constructed a model and verified it experimentally, after which he put in hand a full sized engine. (A large-sized model frame of this may be seen on the table.)

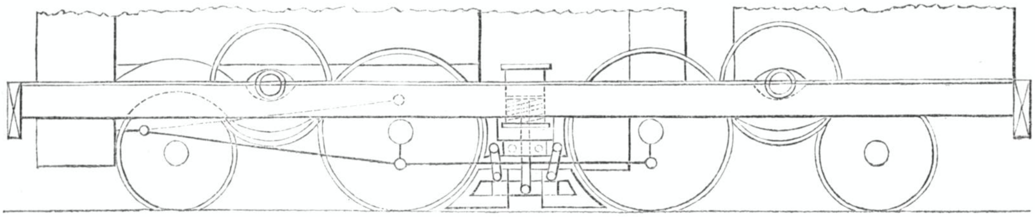
After working for some time on the St. Helen's, both for passengers, goods, and coal, and perfectly establishing the soundness of the principle, this engine, called the "White Raven," was brought to London for experiment, and examined and experimented on by a large number of railway engineers, whose judgment confirmed the truth of the principle of structure.

It was at first supposed that the free movement of the wheels would tend to make the engine unsteady on straight lines at high speeds, inasmuch as front wheels, fixed laterally in the horn plates were supposed to exercise a steadying and governing power. But the contrary proved to be the fact. Another engine, altered from the rigid system to the radial, was found to run much steadier after the alteration, after acquiring the facility for rounding sharp curves. In truth the unsteadiness of all engines, apart from bad construction, arises from the fact that the wheels, fixed to the frame and seeking the path of least friction over uneven rails, force the frames to partake of their irregular movement; and, as might be expected, the inertia of the engine frame keeps it steady enough when the wheels are left free to pursue their own courses unshackled.

This novel arrangement comes at a convenient time, as the extension of railways through towns and mountainous countries is now the prevalent thought. But even for what are called straight lines, their extension into and through towns, and new station accommodation, renders it very important to have engines working round very sharp curves, and either end foremost. The great cost of land and the removal of buildings in approaches where only straight lines or very large curves can be used adds very materially to the cost of construction. But there is another question, quite as important. It is well known that the rapid wear of the rails of railways is very largely owing to the weight of the engines, apart from the train, and in the engines the destruction by rail crushing is increased in proportion to the weight on the driving wheels. Some engines have only one pair of driving wheels, as they involve less impedimental friction at high speeds. Some have two pairs coupled together, and some three pairs. Inasmuch as the engine draws the load by reason of its own weight on the rails giving adhesion, it follows of course that a heavy train needs more weight on the driving wheels than a light one. When a single pair of drivers are used the load sometimes approaches to fourteen or fifteen tons, and this crushes both rails and tires. If however the load can be distributed over more wheels, this destruction may be avoided. Twenty tons on four wheels is much less damaging than fourteen tons on two wheels. For this reason our continental neighbours have been aiming at two things combined—to obtain the adhesion of many wheels with the facility of passing round sharp curves. The ordinary method of coupling wheels by side rods does not admit of this, and the writer has resorted to another method, illustrated by the model on the table, which, as regards its eight lower wheels, is precisely similar to the St. Helen's engine, the "White Raven." But in addition to this, it has four other wheels, two of which are placed at each end resting between the central driving wheel and the end radial wheel on their peripheries, pressing downwards with any amount of weight needed to induce adhesion. In fact the whole weight of the engine and frame may be supported by the upper wheels if needed. But practically a comparatively small weight is needed, as the wheels do not merely rest on one another, as is the case with wheels on rails, but have also a wedging action, which may, if permitted, produce an intense pressure. All the wheels have also spring tires, which ensures elastic contact and fit, without blows. It will be seen that when the driving wheels are put in motion, they communicate that motion by friction to the upper wheels, which in turn communicate the motion to the radial wheels, and continue to do so when the radial wheels are on curves, the effect being that the axles of the upper wheels depart from the horizontal line, dipping to right or left according to the lengthening or shortening of the distance between the lower wheels on curves. And the adhesion is perfect, because the load on the upper wheels forces down the lower wheels to a perfect pressure on the rails at either end of the engine. Thus there are eight drivers which may be equally loaded and the whole weight of the engine is available for adhesion. And in reversing, for the purpose of retardation, the whole of the wheels are available. To make the machine complete, brakes are applied between the driving wheels, arranged to act both against the wheels and rails by small steam



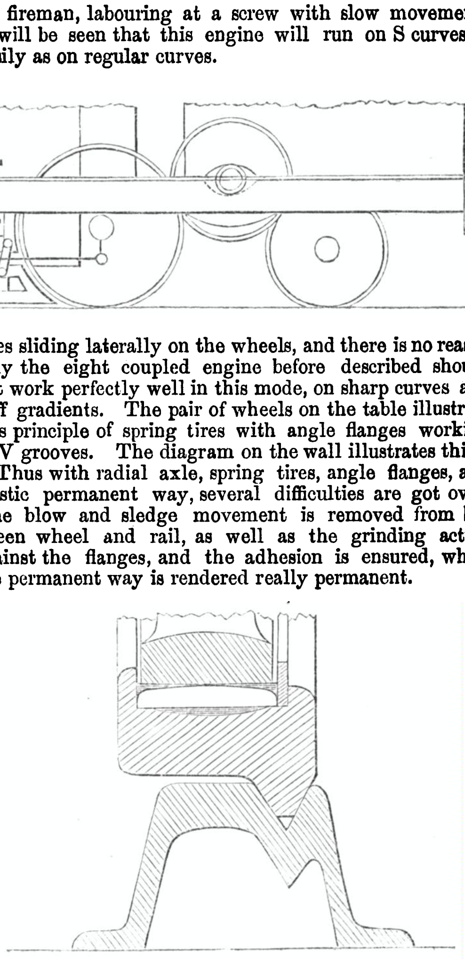
cylinders, so that the retardation of the engine is within the control of the driver by simply turning his regulator and steam cocks, without needing the muscular force of his fireman, labouring at a screw with slow movement. It will be seen that this engine will run on S curves as easily as on regular curves.



Of course the steam power of an engine should be in proportion to the adhesion. Practically it is far in excess of the adhesion, inasmuch as sand is commonly used to prevent the slip of the wheels; and this, though useful to the engine, is a serious disadvantage in increasing the resistance of the train. This seems certainly the case on the Great Northern, where it is found advantageous to make the tender wheels drivers, as well as those of the engine, with the same boiler power.

In the early days of railways the difficulty of adhesion between a smooth tire and smooth rails was considered to be great, before it was tried. But in those days the trains were light, and the increase in weight has again drawn attention to the desirability of increasing the adhesion. Racks on the rails and wheels might no doubt be used, as they have been, and as they are still in some collieries; but this can only be for very slow movement. Yet there is a mode of increasing adhesion not yet resorted to, but which will probably be resorted to, where the whole difficulty of mounting steep ascents, such as one in twelve, or 440 feet to the mile, shall occur on any sharp curves. It is to convert the rounded flanges of the wheel tires into two flats at an angle of 45 degrees, and enlarging them to take a corresponding groove formed in the surface of the rail. The driving wheels of the engine only are to be fitted to these grooves, and the ordinary flanges of the train wheels can easily pass, being of smaller size. It may be remarked, that it would not be easy to lay rails accurately enough for this, and especially on curves, but compensation can be easily provided by the use of spring tires sliding laterally on the wheels, and there is no reason why the eight coupled engine before described should not work perfectly well in this mode, on sharp curves and stiff gradients. The pair of wheels on the table illustrate this principle of spring tires with angle flanges working in V grooves. The diagram on the wall illustrates this.

Thus with radial axle, spring tires, angle flanges, and elastic permanent way, several difficulties are got over. The blow and sledge movement is removed from between wheel and rail, as well as the grinding action against the flanges, and the adhesion is ensured, while the permanent way is rendered really permanent.



It may be objected to that the angular flanges will tend to wear away both tires and rails. This is quite true, but if we want to do hard work we must pay for it in some shape or other. The only question is, is it worth doing, and if so, what is the least costly method as well as the most effective and simple. We know that we can drive machinery by friction pullies, and there is no mechanical reason why we should not drive railway trains. And these tires can be removed and replaced with perfect facility without needing workshops.

But it is not merely the question of engines that we have to deal with. It is that of carriages and wagons also. These vehicles have been kept short, and their wheels disadvantageously near together, chiefly on account of the difficulty of curves. This system needs remodelling, but there are so many considerations that it must be deferred to another paper.

DISCUSSION.

Mr. **Rochussen** fully agreed with the principle laid down, that in order to neutralise as much as possible the wear and tear of materials by friction, they should have elasticity, and that elasticity might easily be promoted by the improvement of materials themselves, as pointed out in the paper. There was no doubt the introduction of steel into the manufacture of rails tended to add to the durability of the rails as well as to introduce the element of elasticity to a large extent. The Bessemer process enabled them to produce steel rails at a comparatively low cost; at the same time it had not superseded the other description of steel rail which was largely used on the Continent, viz., the puddled steel rail, by which the tendency to split, spoken of in the paper as occurring in the common iron rail, was obviated, and the advantage of puddled steel was, that it welded well with iron. Thus they had a flat-bottomed or Vignolles rail, which was still used to a large extent on the continent, consisting of a head and web of puddled steel, and an iron base. The welding of the steel and iron was complete, and while this combination gave a harder surface to the tread of the metal, the elasticity of the iron was retained. He had seen the advantages of that combination of material at the Hamm station of the Cologne-Minden Railway, the traffic of which was equal to that of Cresse, where steel-headed rails with iron web and base had been in use for ten years and showed no signs of wear. Bessemer steel would not weld well with iron, and therefore it was best adapted for the double-headed rail. As far as the elasticity of rolling stock was concerned, he greatly admired the plan of Mr. Adams, of introducing an elastic material into the tire of the wheel. But he (Mr. Rochussen) would remark, that the combined steel and iron he had spoken of in rails, was also applied to wheels, and offered all the advantages of elasticity contended for. Both wrought and cast-iron discs in straight section were objectionable, whilst in a corrugated section the wheels have a power of contraction which counteracted the force of the blows; and, on the other hand, they had but little vibration laterally. The great advantage of the disc wheel was that it did not raise the dust as the spoke wheel did, and obviated the great atmospheric resistance which the fan-like motion of the spokes created. With regard to the system advocated by Mr. Adams, he would ask how it could be ascertained when the piece of *lignum vitæ* or other wood inserted between the wheel and the tire showed signs of decay, as it was completely hidden from view, and there were no visible means of knowing when it became in an unsound state. While on the subject of disc wheels, he would remark that wrought-iron disc wheels, which were much in use on the continent, were working their way gradually in this country. In the Exhibition of 1862 a manufacturer, with whom he was connected, showed some driving wheels on the disc system, which weighed 2½ tons each, made of cast steel, that material being considered better than wrought iron; but it appeared that wheels of that description were greatly affected by severe changes of the temperature of the atmosphere, and in one night no fewer than nineteen of those wheels cracked, while there was no instance of wrought-iron disc wheels having given way under atmospheric influences. The iron was forged from the bloom, with a hammer weighing five tons, and the cast steel tire was batted on to the T-piece of the disc, or a puddled steel tire was used and welded to the disc, and as the steel surface of the tire wore off, it could simply be turned down, and another steel tire slipped over it, but hitherto no instance of the wearing out of such a wheel had occurred. The axles were not keyed in, but pressed into the wrought-iron nave with hydraulic power.

Mr. **Dennet** felt much indebted to Mr. Adams for the paper he had read, but he wished that gentleman had gone a step further, and had given them a little more information as to the means of avoiding many of the risks of railway travelling. With regard to wear and tear of the line and plant, it was a question of great importance, in which the shareholders of railways were very much interested. There was an invention connected with this part of the subject to which he would call attention. The inventor of it, Mr. Jowett, he had hoped would have been there that evening to explain it, but his sudden and unexpected death within the last four days had deprived them of the valuable information which he would have furnished. The invention alluded to was a form of fish-joint, models of which were on the table for the inspection of the meeting. For this invention he had received but £12 10s., whilst it had been disposed of to a company for £21,000, and they had realised from it £80,000. Mr. Dennet then called attention to the specimen of rails, sleepers, plates, and a new fish joint, all of which were the invention of Mr. Jowett, and he pointed out the advantages of this "rail" and mode of setting as obviating two or three difficulties in railway travelling. The ordinary rail was from five to seven inches in height, and being fixed in iron chairs on the top of the sleepers, there was a vibratory motion, which gave that zig-zag movement so unpleasantly experienced by railway travellers. In the model before the meeting the rail was set in a groove to half its depth of the sleeper; there was a slot or hole cut in the rail, through which a wrought iron wedge or plate was inserted eight or nine inches in length by four or five inches in width and one inch thick, which plate was fastened to the sleepers by bolts or spikes. By this plan there was not only a saving of wear and tear of the rail but an economy in first cost. It could be adapted to rails of any material and of any shape. It could be applied to a light but serviceable rail, it dispensed with the wooden keys and chairs, and lessened the number of sleepers by two in the length of rail. The saving in the cost of laying rails was equal to £300 per mile. In India it would be found that the economy of this plan was equal to £490 per mile, or £40,000 in 100 miles, while in this country the saving would be about £28,000 in the same length of line. Mr. Dennet added that this plan had been tested during seven months on a short length of the South-Western Railway, where it could be seen by those interested in the subject.—Mr. Dennet also exhibited a form of fish-joint which he considered novel, and highly advantageous and practical.

Mr. **Zerah Colburn**, on being appealed to by the Chairman, said his observations had been confined mostly to lines in America, and, as far as his experience went, it bore out the soundness of the principles brought forward by Mr. Adams. The American lines were, for the most part, imperfectly constructed, partly from the inferior quality of the earthwork and want of ballast, and to a great extent from the bad form of rail—the common contractors' rail, with a flat foot, but of bad shape and bad quality of iron. Mr. Colburn explained the form of rail generally used, showing how the contractors' form of rail, which could readily be fished, had, owing to the bad quality of the iron, in order to gain strength been altered into a form which did not admit of fishing. Nevertheless it was the fact that the American carriages travelled over these lines as smartly as first class carriages on the superior lines of this country. This he thought was mainly due to the use of the bogy, the great length of the carriages, and the manner in which they are hung. The bogy had the advantage of going round curves easily, and the mode of attaching the carriages to it distributed the weight more uniformly; if they met with an obstruction the shock was not imparted to the carriage. The arrangement for allowing the carriage to swing freely on the body of the bogy, as adopted in America, had been introduced on the Metropolitan Railway, where it would be noticed that the carriages have a peculiarly easy motion. Mr. Adams had spoken of the bogy as having been originally invented in America, but he believed it was first introduced by Mr. Chapman, of Newcastle, in the year 1812, and was first used there. It was taken up in America at an early period, and had continued in general use ever since. It was the opinion of some locomotive engineers in this country that the use of the bogy to engines and tenders was not so safe as placing the wheels in the ordinary manner. He thought that was a mistaken opinion. He had designed some rolling stock for one of the Brazilian lines, and in opposition to his advice the bogy was dispensed with; but experience in the working of heavy gradients and sharp curves led to the ultimate adoption of the bogy. With regard to elastic wheels, something on the principle described by Mr. Adams had been used with success in the States of America, but not of the form which that gentleman had described.

Mr. Dennet inquired whether Mr. Colburn could give any information as to the description of wheel in use on the Massachusets line, which he had been informed had resulted in great economy of wear and tear.

Mr. Colburn was not acquainted with the kind of wheel used on the line mentioned. He apprehended it would be something similar to those on the South-Eastern line in this country, viz., segments of wood put together. He would, however, add that one objection to the bogy was the necessity it entailed of using wheels of small diameter. A larger diameter than three feet was never used. As a rule the carriage wheels were 2ft. 9in., and the engine wheels 2ft. 6in., and for goods engines only 22 inches. The plan of Mr. Adams enabled a much larger wheel to be used, and this was, in his opinion, a decided advantage.

The Chairman said there was no doubt Mr. Adams had introduced a very important subject for discussion that evening, advocating, as he did, a radical change in the construction of our railways and the rolling stock. On the first introduction of railways he had no doubt it was in the recollection of many that a very rigid road was made. In the first instance the rails were laid on chairs fixed into stone blocks, and on one line, he believed in the north of England, they actually built brick walls, on which they laid the rails. All those arrangements caused the rails to be knocked to pieces very soon, and engineers then resorted to wooden sleepers laid upon ballast. The Great Western Railway was, in the first instance, constructed by Mr. Brunel by laying longitudinal sleepers on piles driven a considerable depth in the ground, but at the points where these piles supported the longitudinal bearings great injury resulted. These piles were consequently all removed. The system was changed, and the sleepers were laid simply upon the ballast. This, therefore, appeared, to be the great object at which railway engineers were aiming in order to avoid or mitigate the shocks produced by railway trains. He therefore thought no one would be disposed to object to a trial of the plan proposed by Mr. Adams. To him (the chairman) it seemed a most reasonable plan; but, of course, in railway experience it would not be prudent to express any very decided opinion upon a new principle of construction until it had been tried for a considerable time. The arrangement which Mr. Adams proposed for making the tires revolve on the wheels was certainly new. It had been tried, and was a great advantage. It had long been sought by railway engineers to make the wheels revolve upon the axles. The principle of Mr. Adams was very much to the same effect. It made the periphery of the wheel the point at which the revolution took place instead of on the axle. With respect to the fish-joint which Mr. Dennet had claimed for Mr. Jowett, he believed there were a great many persons who laid claim to its invention. He knew that Mr. Adams put in claims for that many years ago, and he knew many others who also laid claim to a mode of fishing rails. He had no doubt that by Mr. Jowett's plan a certain amount of elasticity would be obtained, but Mr. Dennet had not stated whether the sleepers themselves would not be weakened by that arrangement.

Mr. Dennet replied—Not at all; quite the reverse. He would add that he did not claim for Mr. Jowett the invention of the fish-joint, but that particular form of fish-joint to which he had referred. It was different from that of Mr. Adams's, the ingenuity of which he did not wish to detract from.

The Chairman said he remembered a system of fixing the rails into timber as long as twelve years ago—not exactly like that shown to-night, but very similar to it, which was tried on the South-Eastern line near London-bridge.

Mr. Dennet said that Jowett's plan of fixing the rail in the wood was different from that alluded to by the Chairman, and was quite new. In the plan referred to by the Chairman the metal was embodied in the wood.

The Chairman then proceeded to say that these various proposals of Mr. Adams undoubtedly tended to diminish a very great amount of the friction which took place in railway trains: and any diminution of those forces would practically be a diminution of the cost of working, and an increase of dividends to the shareholders; and he trusted it would eventually lead to a diminution of the fares charged to the public. In that respect these matters were of the greatest public importance, and he was sure the meeting would readily accord their thanks to Mr. Adams for his very able paper.

The vote of thanks having been passed,

Mr. Adams said he took no credit to himself for the invention of the fish-joint, for five hundred different people, setting down to patch a rail as he did in the first instance, would probably have come to the same conclusion, only he happened to be the first to place such an invention on record. He never considered the fish as used was good, and he set himself to devise what he thought was a good fish on the plan he had laid before them. With regard to wheels, he did not enter into the question of which was the best structure, but merely alluded to the disc wheel as a form to which he wished the elastic tires to be applied; but the spring tire was applicable to all kinds of wheels, whether on common roads or on rails, and the section on the wall showed a mode of applying spring tires to road locomotives. The subject was too extensive to be dealt with in one paper, and he would deal with other branches in the paper which was to follow. He wished, however, to impress upon the meeting that it was perfectly practicable to make engines to go ronnd curves of a radius of 1½ chain, and he claimed a plan of distributing the weight upon all the wheels of an engine instead of principally upon the driving wheels. As to the mode of fixing the rails in the sleepers, there had been several plans proposed of cutting the sleepers, but they were all open to the objection that by cutting into the material of the sleeper its strength was impaired. If a sleeper with the ordinary chair required five inches in depth, then when it was cut away to the depth of three inches, it ought to be eight inches in depth in order to make up for the part cut away.

Proceedings of Institutions.

Worcestershire Union of Educational Institutes.—The annual meeting of this body was held on Wednesday, the 16th November, at Droitwich. The proceedings consisted of a morning meeting for business and discussion, a public dinner, under the presidency of Lord Lyttelton, a *soirée*, and evening meeting. The evening meeting was held at six o'clock, and was attended numerously, many ladies being present. The chair was occupied by Sir John Pakington, Bart., K.C.B., M.P.; and there were present on the platform Lord Lyttelton, Lord Robert Cecil, M.P., the Hon. and Rev. W. Douglas, the Rev. Canon Melville, Rev. Dr. Collis, Rev. W. Walters, Mr. H. F. Vernon, M.P., Mr. J. S. Pakington, the Mayor of Droitwich (Dr. Roden), Mr. J. S. Isaac, and others. The chairman, in opening the proceedings, said he was delighted to bid welcome, in the name of the Droitwich Institute, and of the whole neighbourhood, to the representatives of the different Institutes forming the union. He believed that there was no nobler object of domestic policy in this country than the endeavour to promote everything which could tend to improve the physical or the intellectual condition of that vast body of their fellow countrymen who lived and maintained their families by their own exertions and their own industry. The more they elevated the character of the working man, the more they increased his respectability and comfort. The more closely they could draw together those various classes of which English society was composed, and bind them closely to each other by feelings of mutual respect, mutual dependence, and mutual good feeling, the greater would be the aggregate of the prosperity and the happiness and the welfare of this nation. These were considerations which induced him to attach the greatest possible importance to meetings of that kind. They were assembled there essentially and specially to promote a great public object, which, in his judgment and belief, referred essentially and directly to the welfare of those industrious thousands by whom they were surrounded, but their immediate object related to the intellectual improvement of those classes. He here wished to say, in the most distinct and emphatic manner, that he would not ask them to support that union, he would not ask them to give to the Institutes separately their best aid, if he did not in his conscience believe that they were calculated to promote clear, distinct, practical benefits. Looking to the manner in which these Institutes promoted the interests of the working man, they did so in two distinct and most important respects. The first he would advert to was this: that they sought by these Institutes to give to the industrious working man a resort where, in his leisure hours, he might enjoy innocent and useful recreation, instead of being driven to the dangerous and seductive enjoyments which were offered by the public-house. If any publicans were present they would forgive him. He did not wish to interfere with their legitimate business, but what he wanted to say was, that the working man should be able to resort to an Institution where he might obtain innocent society and innocent recreation and amusement, without the danger of being enticed into habits which must be destructive of his own welfare and of the welfare of his family. The next object was of immense importance—that they might, by resorting to these Institutes, avail themselves of the educational classes which always ought to be carried on in connection with them. He was glad to find that nearly all of the 20 or 30 Institutes in the union had educational classes in connection with them, and that their progress had been steady and rapid since 1858. Sir John concluded by expressing his belief in the good which was effected by the organisation and system which this meeting of the union every year enabled them to carry out.—The secretary having read the report, Lord Robert Cecil moved—"That the continual education of the industrial classes after the age of childhood was one of the most important aids to national well-being, and, as such, deserves the best attention of statesmen and philanthropists." The Rev. D. Melville seconded the resolution, which was carried. Lord Lyttelton and other gentlemen afterwards addressed the meeting.

NORTH LONDON WORKING CLASSES INDUSTRIAL EXHIBITION.

The following is the report of the adjudicators:—

The duties undertaken by the adjudicators, at the request of the committee, were of great delicacy; and the experience acquired by them in the Exhibitions of 1851 and 1862 in London, and of 1855 in Paris, helped them less than might have been expected, as the different circumstances under which the articles exhibited had been produced and collected rendered any previous standards of comparison inapplicable. The present Industrial Exhibition, like that recently held at Lambeth, has but little in common with those great undertakings. On those occasions considerable time was given to the public for preparation; temptations to exhibit were freely offered in the shape of medals and other prizes; for a prominent manufacturer to fail to be represented, was to "go to the rear" in the great industrial race; the opportunities for comparison and competition were beyond all precedent; capital had ample scope for profitable investment in productions suitable for sale in the markets of the world; and above all, these Exhibitions were inaugurated by the patronage and presence of the most illustrious personages of this and other countries—by splendid pageantry and ceremonial, and by profuse expenditure in decoration, music, and other attractive accessories. "The North London Working Classes Industrial Exhibition," from its necessarily limited nature and modest pretensions, can lay claim to no such advantages; it is emphatically a Workman's Exhibition.

The original idea, the organisation, and the successful results, are solely due to working men as exhibitors, committee-men, and honorary secretaries. They have declined many tenders of pecuniary assistance from the wealthy, but have not hesitated gratefully to accept spontaneous offers of guarantee from well-wishers to the experiment, in the full confidence, now happily more than realised. that the necessity for having recourse to them would not arise.

The response on the part of the workmen to the invitation to exhibit was enthusiastic, and resulted in a contribution of several thousand miscellaneous articles, upon the merits of which the Adjudicators have had to form a judgment. In making the awards, the merits of professional work have not been brought into competition with those of that produced by amateurs; but the Adjudicators have endeavoured, in all cases, to take into reasonable consideration the circumstances under which the articles have been elaborated. As regards professional workmanship, much of it is highly creditable to the producers, especially considering the nearly extemporised circumstances under which their skill and taste are exhibited in so many forms. As regards the amateur contributions, the Adjudicators are of opinion that, taking into consideration the small amount of leisure, and, in many cases, the inferior appliances and limited means at the disposal of the producers, the articles exhibited show in many instances a high, and in some instances an extraordinary degree of merit. It has afforded sincere pleasure to note the elevating character of very many evidences of the substitution of intellectual cultivation, in the workman's hours of relaxation from his daily and appointed toil, for the grosser stimulants of the senses. Such illustrations of successful aspiration are regarded as elements of even greater hope for the future than they are of congratulation for the past.

The adjudicators cannot close this Report without tendering their warmest congratulations to the Committee and others who have organised in their district this most successful social experiment, and can only regret that the limited time for which the Hall was available has rendered it necessary to close the Exhibition whilst the continued attendance of very large numbers seemed to show that the interest excited was undiminished.

(Signed) THOMAS WINKWORTH,
D. K. CLARK, C.E.,
GEO. F. WILSON,
P. LE NEVE FOSTER,
J. A. NICHOLAY,
PETER GRAHAM,
M. DIGBY WYATT.

7th November, 1864.

WEST LONDON WORKING CLASSES' INDUSTRIAL EXHIBITION.

On Monday evening, the 21st November, a public meeting was held in Castle-street school-room. Mr. R. M. Morrell presided, and, upon opening the meeting, said he believed that the objects of industrial exhibitions were now so generally known that it would require but little explanation from him. He felt confident that much good had arisen from those exhibitions that had been already held, and as the north and south of London had successfully held their exhibitions, he (Mr. Morrell) contended that it would be an utter disgrace to the working men of the western division of London if they did not make as good, if not a better, exhibition than those previously held. After reading the preliminary prospectus and commenting upon the names of the several gentlemen who have already consented to be parties to the guarantee fund, he left the proceedings entirely in the hands of the meeting. It was then moved by Messrs. Howe and J. B. Bailey, "That this meeting pledges itself to support the Industrial Exhibition for the borough of Marylebone that is now in course of formation all that lies in its power." After which Mr. Tucker proposed, and Mr. C. Hooper seconded, "That a district committee be formed from this meeting for the purpose of making the movement known and obtaining patrons from members of this district," which was also carried. A working man then asked whether the committee of the exhibition would guarantee the registration of any new invention that would be exhibited. The chairman, in answering, said that as the committees of those exhibitions which had already been held (he believed) did not feel themselves safe in promising to guarantee a registration to any exhibitors of a new invention, he thought his committee would take the same view of the question, but he would accept the feeling expressed by the meeting as an instruction for him to put himself in correspondence with the committees of the past exhibitions, and would consult a member of the Government as to the desirability of introducing a short Act of Parliament which should give the desired guarantee of security to all future exhibitors. The assistant secretary, Mr. S. A. Barrows, then said that he thought it would be unfair to the parties to the guarantee fund for the committee to promise to guarantee registrations, at all events for the first exhibition, but as it was decided to invest any surplus that might arise from this exhibition in the names of trustees for the purpose of defraying the expenses of any future exhibition that might be held in the west of London, he thought that if it should be decided that the committee could not guarantee registration on this occasion, they might be able to do so on the next. Mr. C. Hooper then asked what prizes it was intended to award. The chairman said that he was extremely sorry that the committee did not feel themselves in a position to promise pecuniary prizes, but undoubtedly if this exhibition proved as successful as the north of London, they would distribute part of the returns in prizes, and invest the surplus. Mr. Foxwell, a working man, addressed the meeting at some length on the subject of the guarantee fund. He said that he would be sorry to object to the upper classes assisting the projectors in so excellent a movement, but he considered that working men themselves should figure largely in the guarantee fund. He should like to see every working man in the west of London, and indeed all others who take any interest in such a movement, guarantee some sum, if only a shilling, but he also hoped that although the committee might have many names on their guarantee fund, there would be no necessity to call upon one of them. He then moved the following resolution, which was seconded by Mr. Haswell, and carried amid loud cheering:—"That working men present pledge themselves to support the guarantee fund of themselves as far as lies in their power." The assistant secretary then received the names of the working men present for sums varying from 10s. to 2s. 6d. A district committee of eight, with power to add to their number, was then formed, and after a vote of thanks to Mr. Charles Marshall for the use of the room, the meeting concluded with a vote of thanks to the chairman.

Manufactures.

Textile Manufactures.—From an official account just published by the Minister of Agriculture and Commerce at Turin, the raw silk brought into the markets of Italy during the last year amounted to upwards of 4,000,000 lbs., representing a value of about 4½ millions sterling. The quantity of cotton spun in Italy was above 60 million pounds weight, more that half of which belonged to Lombardy. The quantity of flax sent during the last ten months to the port of Archangel alone from the province of Vologda was about 18 million pounds weight. There are 49 cloth-manufactories at Moscow, producing £1,663,000 worth of cloth. There are besides 90 manufactories of thin woollen stuffs, which have in a great measure superseded cotton ones, owing to the scarcity of that material.

Lenoir's Gas Engine.—This engine, a notice of which was given in the *Journal*, Vol. XII., p. 673, is being largely used in Paris. It is said there are not less than five hundred now at work in that city for various purposes, and amongst others it is employed by builders for hoisting their materials. The one which was put up in Birmingham a short time since by Mr. Wiley at his factory is reported a success. A manufactory of these engines has just been established at Reading.

Commerce.

External Trade of the Country.—It is well known that the trade of this country has been advancing of late years to an enormous extent, notwithstanding the American war and the unsettled state of European politics. This advance is shown in a striking manner when the Board of Trade returns for the past ten years are compared. The total increase in the trade of the country in that period is nearly £177,000,000, which is made up as follows:—

Imports, 1854	£152,389,000
,, 1863	248,981,000
Exports, 1854, British produce	£97,184,000
,, ,, Foreign and colonial	18,637,000
Total	£115,821,000
,, 1863, British produce	146,489,000
,, ,, Foreign and colonial	49,485,000
Total	£195,974,000

The total imports and exports of the country, which were £268,210,000 in 1854, had risen to £444,955,000 in 1863. The increase in importation (£96,502,000) is enormous, but is not of such importance as the figures would at first indicate, since a large proportion is again exported, this country serving merely as an entrepôt, but it affords a very valuable index to the prosperity of the country when we find that it has been followed by proportionately increased consumption. The quantities of corn and flour, the most important articles of consumption, have nearly doubled in the ten years, whilst cotton, 40,000 tons of which came here in 1854, rose in 1860 to 60,000 tons, but it declined to 30,000 tons in 1863, in consequence of the American war. The consumption of wine has increased about twenty per cent. ; tobacco to about the same extent; tea, currants, raisins, and other dried fruits have greatly increased; whilst coffee and cocoa have alone fallen off. Sugar has, considering the increased prosperity of all classes, virtually stood still.

Banking in Frankfort.—The banking business is the most important in Frankfort; indeed, the city possesses nearly as many banking firms as there are persons employed in banking and gold dealing in Bremen, and absolutely more than the number of such establishments in Berlin. There are 99 directors, or heads of banks, in Frankfort, who employ 383 servants, 203 clerks, 150 apprentices, and 144 travellers. The banking business sustains directly nearly 2,000 persons in all. There are also 183 money-changers.

Grapes from the United States.—Fresh-grown grapes have been shipped from New York to this country, by way of experiment, to Messrs. Keeling and Hunt, of London.

Obituary.

M. Achille Lefevre, a French engraver, who has reproduced the principal works of Raphael and Corregio, and whose "Antiope," ordered by the Imperial Government, was exhibited the other in the Palais de l'Industrie, was carried off rather suddenly a few days since. His death is a severe loss to art.

Another vacancy has occurred among the Royal Academicians by the death of David Roberts, which occurred suddenly on Friday evening, the 25th of November. He had just completed the 68th year of his age, having been born in the neighbourhood of Edinburgh, on the 24th of October. 1796. While a boy he was apprenticed to a house painter in Edinburgh, and during that time admitted to the Trustees' Academy, in which Wilkie, Allan, and many other Scottish artists were reared, but only attended once. Coming to London, we hear of David Roberts as engaged as a scene painter at Drury-lane Theatre, where he commenced his career in 1822, along with the firm friend of his early and later years, Clarkson Stanfield. Shortly after he and other artists instituted the Society of British Artists, of which he was for some time vice-president. He first exhibited at the Royal Academy in 1826, when he sent a view of Rouen Cathedral, and in the following year he exhibited one of St. Germain's, at Amiens. His name does not, however, appear in the Academy catalogue again until 1830. After another interval, in 1835-6-7 he contributed views of Spanish antiquities, and in 1839 he was elected an associate, attaining the full honours of the Academy in 1841. Roberts was always a great traveller, and he has been for the last quarter of a century a very copious contributor of views of Egyptian, Belgian, Spanish, and Scottish architecture and scenery, as well as subjects from Venice, Vienna, and other Continental capitals. His "Inauguration of the (first) Great Exhibition" was a commission from her Majesty. We look back with wonder on the production of works of such quality—"The Baalbec," "The Jerusalem from the Mount of Olives," "The Temple of the Sun at Baalbec," which our readers will remember at the International Exhibition of 1862, and "The Destruction of Jerusalem." Among the principal works illustrated by him were Sir Edward Bulwer Lytton's "Pilgrims of the Rhine" and the "Landscape Annual" for 1835-6-7-8, embracing views principally in Spain Morocco, Castile, Andalusia, and Biscay. The best known of all his works is his "Sketches in the Holy Land, Syria, Idumæa, Arabia, Egypt, and Nubia," in four volumes folio, with letterpress by Dr. Croly—one of the largest and most important works of the kind ever published in this country. Very many of Roberts's best paintings have been engraved, and to this fact is due some portion of the wide spread reputation of his exquisitely gifted and graceful pencil. Mr. Roberts took an active part in the proceedings of the Society of Arts connected with its exhibition of living artists. Mr. Roberts was married, and has left surviving issue. In private life he was sincerely and deservedly beloved, both within and without the profession of which he was so distinguished a member. He was elected a member of the Society of Arts in 1847.

Notes.

British Museum.—A notice has been posted in the reading-room of the British Museum, intimating that a refreshment-room has been provided, under certain regulations, for the exclusive use of readers and students. This concession will doubtless be appreciated by many who have for a length of time suffered great inconvenience by being compelled to rise from their studies and leave the institution to obtain refreshments.

Lighting Moscow with Gas.—In the Hague *Dagblad*, it is stated, that M. N. D. Goldsmid, of this town, has acquired a concession for lighting Moscow with gas. It is granted for 30 years, and gives him an exclusive privilege of laying gas pipes and other fittings in the streets of Moscow for that time. The number of public gas-lamps is to be 10,000, and private buildings will require 150,000 lights. Moscow has more than 400 hotels and 3,000 coffee-houses, inns, and ginshops; these are open all night, as the inhabitants seldom go to bed before 2 or 3 in the morning, and in the winter scarcely ever remain in the street. The number of shops and magazines is four times greater than in St Petersburg. According to the terms of the contract, the gas will cost for the private lighting 5 roubles, or 9fr. 50c. per 1,000 cubic feet (English measure). The concession will require colossal gasworks, but there can be no doubt it promises in a financial point of view good results.

New Laboratory for Dr. Hofmann at Berlin.—The *Moniteur Scientifique* announces that the Prussian government has bought a plot of ground at Berlin on which to build a large laboratory for Dr. Hofmann, who will leave London soon and commence his university course of lectures there after next Easter. Dr. Hofmann, however, will, when the laboratory at Bonn is finished, definitively take up his residence in that city. The first stone was laid with much ceremony on September 16.

Co-operation in Paris.—A number of working coppersmiths of Paris are now forming a society for the foundation of a firm to be conducted by the members themselves in common. A capital of 25,000f. has already been raised by 250 shares of 100f. each, subscribed by 208 workmen. The intention of the association is to gradually unite as many members as possible of the trade as associates in workshops to be successively added to the establishment.

Fire Arms.—The official life of the Enfield rifle is 12 years, and during this period it is calculated to fire about one thousand rounds, as each man is allowed 80 rounds a year. At the end of 12 years the man is entitled to a new rifle, but as many of the volunteers who practice assiduously at shooting, and fire more than a thousand rounds in a year, the Enfield in their hands cannot be relied on after a twelvemonth's use. It is, in fact, worn out at the end of that time.

Correspondence.

Mr. Fairbairn's Paper.—Sir,—In your report of the discussion following Mr. Fairbairn's lecture on iron, you have made me appear to advocate the use of steel armour-plates. This is not correct. I distinctly stated that hitherto all efforts to produce efficient steel armour had failed; but that mild steel was admirably adapted for the framing, beams, and *internal* plating of men-of-war. Moreover, that it was only a question of the application of power to roll beams and frame-girders in one solid length, instead of building them up, by rivetting a system of T and angle bars; and that a better material, applied in the best form, would enable us to save from 400 to 600 tons in the weight of our armour-cased frigates. Apologising for this short intrusion,

I am, &c., F. A. Rochussen.

9, Friday-street, Cheapside, London, E.C.,
28th November, 1864.

Fire-proof Construction.—Sir,—In my notes on the fire-proof construction of dwellings published in *Journal* No. 619, I find that I have omitted to mention amongst brick arches a plan designed by Mr. F. H. Groves, of arching in brickwork on the fan vault principle. The rings, commencing from each of the piers, proceed concentrically on plan, till it meets the others, when a circular opening may be left in the centre for light, or closed with herring-bone key, as circumstances require, or, where more light is required, panels may be formed as shown in model. This construction entirely obviates the necessity of thick walls or iron ties, as the thrust is concentrated on the four angles of support. The space occupying little more than would be required for a wood floor with girders and ceiling joists, Mr. Groves estimates that a half-brick arch will suffice for spans from 10 to 12 feet, one brick from 12 to 20 feet, and one and half brick from 20 to 40 feet. He has put his principle to the test by having a model erected in the yard of Mr. Allen, builder, of Great Smith-street, Westminster, which has stood for twelve months without showing the least defect. The model is 20 feet long by 11 feet wide, and consists of two compartments—one illustrating a floor and roof and the other a roof with ribs and spaces or panels left open for light. The floor has been tested with a permanent weight of two tons. The cost of this construction, in a stable and warehouse erected on this principle, near the Strand, was as follows:—Revolving centering for segmental flat arches, 30s. per square; for elliptical arches, 35s.; brick arches, laid in revolving rings, for nine arches, £1 14s. extra; 14 arches, £1 2s. 6d. extra per rod on the price of brickwork for walls. Taking the above prices as a basis of calculation, the cost of a square, or 100 feet super., for a span of 14 feet, would be nearly £7 10s., including levelling up the floor and tiling, and plastering the underside. Further particulars as regards this construction can be seen by reference to the *Builder* journal, of May 4th, 1861, and May 7th, 1864. A small model can also be seen at Mr. Twining's Museum at Twickenham. I am, &c.,

Henry M. Eyton.

Ships and Guns.—Sir,—Mr. Fairbairn concludes his remarks following the discussion of his paper, read at the Society of Arts on the 23rd ult., with these observations:—"On the question of armour plates he would say, if they were to have 300 or 400-pounder guns, it was a question with him whether it would not be better to be without armour plates altogether, and let the shots go right through, because they were limited to a certain thickness and weight of plates; and if they were to cover vessels from stem to stern, and five feet below the water-line, they would not be able to carry plates that would resist large guns. If that description of artillery was used his opinion was they would have a more secure and better navy without the iron plates than with them." Why are we "limited to a certain thickness and weight of plates?" and why also are the ships unable to carry plates that would resist those large guns, if the vessels are covered from "stem to stern and five feet below the water-line?" If the Admiralty would take my humble advice and put the *Warrior*, now about to undergo certain alterations, into a dock, after removing the machinery, boilers, internal fittings and lower masts, and cut her into two—fore and aft—up the middle and separate the two sides of the ship so severed some 18 to 20 feet asunder, and convert her into a double-ended ship, those gentlemen who are inclined to despond over the present state of matters in connection with iron-clad ships would then see some cause for taking fresh courage and go forward instead of backward. The *Warrior*, as she now is, is a very long ship for one of those liners which have got to do the heavy work of a sea fight. She is 380 feet in length, and only 58½ feet outside beam, drawing 26 feet water ready for sea. She is a vessel having what we may call a sharp bottom, her midship section showing a good rise of floor and a round easy bilge, with fine long tapered ends. This form of bottom tends to crankness, and who will venture to say the *Warrior*, carrying some 1,000 tons of solid iron on her topsides, is not crank and liable to dangerous rolling in bad weather? By altering this ship, as proposed, into a double-ended ship, we shall add some 30 to 40 per cent., at least, to her present displacement; she will be stiff and able to carry, at all times and under all conditions of weather, the heaviest load in the shape of armour and guns that the progressive state of the gun question may demand. Rolling, pitching, and scudding or plunging, as now experienced in the case of our iron clads, will not exist. She would be able to meet or attack a foe when no other iron clad could attempt it; in fact, she would be just such a ship as we now require to take the place of the old wooden three deck liners now becoming obsolete. Our shores need protection in winter weather as well as summer; but we have no ships as yet adapted so well to perform this service as the old wooden liners and frigates. We have got to apply the double propeller principle to these large ships of the navy, and also the double rudder; they want something more than a single screw or a single rudder to govern their motions. And ships of this class, having plenty of room upon their upper deck, should have a battery amidships carried upon this deck over the engines, and boilers protected with plating or other armour, to protect it against vertical fire as well as horizontal fire, which battery could be armed with six or eight heavy guns upon turn-tables, the extremities of this deck having turrets. We should then have a most formidable ship, not intended to run away from the enemy, but to stand her ground, and calculated to receive him and return his compliments most vigorously. There are no difficulties in our way of cutting the *Warrior* or any other iron-clad ship, which is found to be too narrow, into two parts, fore and aft, and separating them any required distance apart, which may not be overcome; and this is certainly the best way to spend our money at the present time, to get the most for it—far more wisdom in it than continuing to build ships to carry permanent armour after the present style of model. We know as much as we need to know at present in regard to "the application of iron to the purposes of naval construction;" but we evidently are far astray in the models and proportions of our ships, propellers, and steering apparatus, and other matters bearing upon this part of the subject of armour-clad ships-of-war. Mr. John Hawkshaw's remarks on the question of armour are worth particular attention.—I am, &c.,

John Kennedy.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...Entomological, 7.
British Architects, 8.
Medical, 8. Dr. Habershon, "On the Constitutional Character and Modifications of Skin Diseases."
Royal Inst., 2. General Monthly Meeting.
Tues. ...Civil Engineers, 8. 1. Discussion upon Mr. Clark's paper "On the Great Grimsby Docks." 2. Mr. Joseph Taylor, "The River Tees, and the Works upon it connected with the Navigation."
Photographic, 8.
Anthropological, 8. 1. Mr. Samuel Laing, "On the Contents of a Kist from Keiss, N.B." 2. Mr. George E. Roberts, "On the Discovery of a large Kistvaen in the Muckle Heog, in the Island of Unst, Shetland," with Notes on the Human Remains, by Mr. C. Carter Blake. 3. Dr. Bird, "On Tumuli from Cheltenham." 4. Mr. George E. Roberts, "On some Prehistoric Hut Circles." 5. Dr. T. W. Smart, "On some Ancient Skulls." Communicated by the President.
Geologists' Association. Mr. C. Tomlinson, "Chisel Bank."
Wed. ...Society of Arts, 8. Mr. Bridges Adams, "On the Construction, Retardation, Safety, and Police of Railway Trains."
Medical, 8. Dr. Thudichum, "Lettsonian Lectures."
Geological, 8. 1. Dr. James Hector, "On the Geology of Otago, New Zealand." 2. Mr. Julius Haast, "On the Excavation of Deep Lake Basins in Hard Rocks in the Southern Alps of New Zealand." 3. Mr. Julius Haast, "Notes to a Sketch Map of the Province of Canterbury, New Zealand, showing the Glaciation during the Pleistocene and Recent Times." 4. Sir R. I. Murchison, "Notes on Dr. Haast's papers."
Pharmaceutical, 8.
R. Society of Literature, 4½.
Thurs. ...Royal, 8½.
Antiquaries, 8.
R. Society Club, 6.
Fri. ....Astronomical, 8.
Sat. ....R. Botanic, 3½.

Patents.

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From Commissioners of Patents Journal, November 25th.

Grants of Provisional Protection.

Accidental fire, apparatus for giving alarm in case of—2500—W. Gilbert, E. Cooper, and G. R. Webster.
Boots, &c., apparatus for stamping—2736—A. J. Fraser.
Boots and shoes—2774—J. Okey.
Bottles, stopper for—2787—F. Lane.
Boxes, packing for stuffing—2756—R. A. Brooman.
Card covering—2835—J. Farrar and J. Farrar.
Carriage doors, attaching the inside handles of—2728—E. J. Harrison.
Casting, making moulds for—2807—J. Kinniburgh.
Cement—2801—W. L. Lees.
Centrifugal pumps, portable—2761—C. T. Burgess.
Cigars—2730—H. B. Harris and J. P. Thomson.
Corn, apparatus for grinding—2768—J. Hurt and H. Tonge.
Crinoline skirts 2849—J. N. Smith.
Drains, &c., construction of traps for—2782—S. C. Reed.
Files, &c., machinery for grinding—2859—R. Allinson and H. Lea.
Fires, extinguishing—2595—C. Brothers.
Fire-arms, breech-loading—2855—T. Restell.
Fog signals, apparatus for producing—2813—E. Richardson.
Food, cooking—2732—F. L. Bauwens.
Forks and spoons, apparatus for cleaning—2805—J. Cockshott.
Furnaces, blowing—2758—J. M. Stanley and J. Stanley.
Gas, regulating the supply of—2827—C. Esplin.
Gases, apparatus for generating combustible—2734—F. Yates.
Grease, obtaining from wash waters—2614—G. E. Donisthorpe.
Gun cotton, manufacturing compounds of - 2675—A. Parkes.
Hats, manufacture of—2851—C. Vero.
Hats, &c., manufacture of—2720 —E. T. Hughes.
Hydraulic presses—2754—A. Steven.
Inkstands—2722—E. G. Brewer.
Jute, preparation of—2861—F. C. Parker.
Ladies' dresses—2833—G. Needham.
Lamps, means of supporting glasses, &c.—2586—A. Clavel.
Lead, extracting silver from—2776—A. Moreau.
Liquids, apparatus for drawing off—2766—R. Rimmer.
Looms for weaving—2829—P. A. Le Comte de Fontainemoreau.
Metal blanks, manufacture of—2729—J. Dodge.
Metals, machinery for punching, &c.—2726—W. Bayliss.
Motive power by capillary attraction—2648—J. E. F. Ludeke and D. Wilckens.
Mouldings, &c., cutting wood into—2867—H. Grafton.
Oakum, manufacture of—2752—D. Cullen.
Oil lamps, construction of—2740—J. Sullivan.
Paper, embossing or indenting—2742—J. R. Crompton.
Pipes, &c., moulds for casting—2845—G. Robinson.
Pottery, manufacture of—2795—T. L. Boote and R. Boote.
Printing machines—2750—G. Duncan.
Railway carriage, lubricating axles of—2837—J. M. Hart and R. Purkis.
Railway bars, &c., construction of—2747—J. D. Young.
Railways, permanent way of—2795—H. Brockett.
Railway signals, securing the levers used to work—2857—R. Holiday.
Railway trains, safety apparatus applicable to—2724—J. G. Rowe.
Roadways, machinery for rolling—2527—M. Henry.
Rotary engines—2644—W. Clark.
Saccharine matters, preparing—2538—R. Wright.
Scarfs—2847—G. C. Attree.
Screw driving, &c., tools for—2731—F. S. Gilbert.
Screw propellors, method of raising—2771—W. K. Hall.
Sewing machines—2817—J. Keats and W. S. Clark.
Ships' sails, fitting—2663—W. Congalton.
Shutters, rolling and revolving—2865—H. Grafton.
Sound, apparatus for softening and deadening—2809—F. Fearon.
Steam, &c., obtaining motive power from—2738—M. P. W. Boulton.
Steel and iron, manufacture of—2839—J. Firth.
Straw hats, strengthening the brims of—2778—J. D. Welch and A. P. Welch.
Sulphuric acid, manufacturing—2607—A. Reynolds.
Thrashing machines—2718—S. Davies.
Tramways, securing—2612—G. E. Donisthorpe.
Washing machines—2815—J Thorne.
Whips, &c.—2823—C. S. Cadman.
Wool, &c., machinery for combing—2642—G. E. Donisthorpe.
Wool, &c., sprinkling liquids over—2744—M. J. Roberts.
Yarns, preparing wool and hair for—2825—H. W. Ripley.

Invention with Complete Specification Filed.

Brick and tile making machinery—2879—W. Snell.
Ornamental chains, manufacture of—2873—G. T. Bousfield.

Patents Sealed.

1299. W. Law.
1315. J. Eastwood.
1316. J. Whitley & D. F. Bower.
1326. J. Dichson.
1328. A. Etienne.
1335. T. Drew.
1337. W. Halse.
1338. C. Hall.
1339. J. Huggett.
1344. G. Haseltine.
1347. R. A. Brooman.
1350. J. M. Stanley & J. Stanley.
1352. W. Firth and S. Firth.
1353. J. Platt and E. Hartley.
1357. G. E. Dering.
1358. C. R. Humphrey and J. Hasler.
1360. H. Ambler.
1371. E. Myers.
1401. J. Napier.
1405. W. H. Preece.
1416. J. Beck.
1432. R. Oldridge.
1436. M. Henry.
1919. F. W. Bossert.

From Commissioners of Patents Journal, November 29th.

Patents Sealed.

1355. R. E. Donovan and R. Bowles.
1363. L. Kinnings, G. Gibbs, and W. T. Edwards.
1369. R. Threlfall and R. W. Pitfield.
1370. W. H. Mellor.
1372. R. A. Brooman.
1373. R. A. Brooman.
1374. W. Clark.
1382. A. H. Williams.
1385. T. Holden.
1388. W. Houghton, G. Burrows, and C. Oldroyd.
1407. T. Aveling and T. Lake.
1413. W. Clark.
1425. T. Richards.
1448. R. Hall and J. Chambers.
1470. B. Fothergill.
15 1. J. Hodges.
1559. T. P. Saville.
1594. B. Nicoll.
1598. W. E. Newton.
1635. J. Combe.
2060. H. Parkes.
2212. L. F. Goodbody.
2269. C. Attwood.

Patents on which the Stamp Duty of £50 has been Paid.

2958. J. Willcox.
2973. G. Bottomley.
2975. W. Firth and R. Ridley.
2977. G. E. Donisthorpe, W. Firth, and R. Ridley.
3001. S. A. Carpenter.
3005. J. D'Adhemar de Labaume.
3015. E. Tyer.
3096. T. Higgins.
2955. J. Ronald.
2960. J. H. Johnson.
2953. J. Macintosh.
2995. W. Rowan.
3009. T. Ellis.
2979. J. Standfield.
2980. F. A. Calvert.
2981. F. F. Dumarchey.
2997. H. Wilde.

Patents on which the Stamp Duty of £100 has been paid.

2930. W. McFarlane.
2978. J. Howard.
2929. S. Riley.
2958. S. B. Wright and H. T. Green.
2996. A. Parkes and H. Parkes.
2945. A. Martin and J. Martin.
2976. D. K. Clark.
2995. J. Francis and C. Manby.

Registered Designs.

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Artificial Teat—Nov. 21—4673—S. Maw and Son, 11, Aldersgate-street, City.
Improved Side Light—Nov. 24—4674—Marsden, Brothers, Liverpool.
Button—Nov. 30—4675—William Nokes, Birmingham.